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REPORT OF STUDIES ON UNIFORMITY OF QUALITY OF SUGARS

I. Chemical Studies of Beet Sugars Collected During the 1938 Campaign.

By E. K. Ventre and S. Byall

Carbohydrate Research Division,
Bureau of Agricultural Chemistry and Engineering,
U. S. Department of Agriculture.

II. Report on Biological Studies of Sugars.

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U. S. Department of Agriculture.

August 1939

I. CHEMICAL STUDIES OF BEET SUGARS COLLECTED DURING THE 1938 CAMPAIGN

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Samples composited during the 1938 campaign were submitted by 75 factories located in 17 states. One factory submitted two samples, one from the summer campaign when it operated as a non-Steffen factory and one sample from the fall campaign when it operated as a Steffen factory. In order to simplify discussion in this report this factory is listed as both a Steffen and a non-Steffen factory. The data are compiled as 36 Steffen factories and 40 non-Steffen factories. The samples are representative of the production of all sugar beet growing areas of the United States and of nearly all the factories. One of the sugar samples was a specially made sugar and is not included in the averages. The factory operating data for the 1938 campaign, during which the samples were composited, are given in Table I.

The analytical data for the 77 samples are given in Table II, but only 76 samples are included in the averages, omitting the one sample of specially made sugar. A comparison of the averages for sugars collected in the 1938 campaign with the averages for sugars analyzed after previous campaigns (see bottom of Table II) shows continued improvement, as indicated by lower color, turbidity and ash content.

The data from several factories which have provided samples for eight consecutive years are presented in Table III. This table shows the same trend for these factories, as is noted for the industry as a whole, toward more uniform high quality sugar.

Sugar Rating Formula

In the 1938 report a tentative sugar rating formula was suggested. This formula was designed primarily to furnish a composite measure of the degree of refining achieved by the factories and thus to permit the comparative evaluation of operating methods and processes. The formula has been modified this season to the extent that reflectance is omitted and the constant value 100 substituted. The formula used this year is: 100 minus the sum of the B-K color index plus the B-K turbidity index plus the % ash x 10^3 of the sugar equals the formula rating of the sugar. In this report whenever comparison is made with formula ratings of sugars of previous years, such ratings have been recalculated to this new basis. The reflectance is eliminated from the formula because this value depends both on grain size and on color. The latter is already a factor in the formula, and grain size in itself is not thought to be properly a component of the degree of refining achieved. Consideration is being given to further modification of the formula and it appears that the sulfite content of the sugars might be used as a component.

It should be noted that the formula is arbitrarily weighted and may be too sensitive for some uses. Furthermore, sugars for certain large scale, industrial uses must meet special requirements, and in consideration of this situation it appears that the formula as now drawn is not specific enough for such purposes. The establishment of commercial sugar grades, when required, should evidently be done by the industry, and the use of a formula in this report must not be construed as an attempt to introduce a commercial grading formula.

Quality of Beets

The first consideration in comparing factory operation is usually the quality of the beets worked. Beets of the 1938 season averaged 16.09 percent sugar and 84.51 apparent purity. Beets of the 1937 season averaged 16.06 percent sugar and 84.22 apparent purity. So, in comparing the results of the industry as a whole for the past two seasons little weight need be attached to difference in beet quality. However, individual instances do show differences and, for the one factory producing high ash sugar (above 0.03%) in 1938, the lower quality of the beets (15.0% sugar and 76.6 purity) undoubtedly is an important factor.

The manufacture of high quality sugar depends not only on quality of beets, but also on the efficient conduct of several successive operations, type of equipment used, and skill of the operating personnel. Consideration of such factors extends beyond the limits of a report of this kind. This is evidenced throughout when correlations are attempted for a single set of factors or operations. Instead of smooth, correlating curves we find non-correlating situations which appear to be of practical importance. For example, it has generally been believed that white massecuites of high purity are necessary for producing high quality sugar, and when this work was begun this conclusion seemed quite plausible; however, in the last few years improvements have been introduced into the processes which have somewhat altered conditions.

The data compiled in 1937 and 1938 on white massecuite purities and sugar quality not only do not give smooth correlations, but indicate that in some factories sugar of satisfactory quality is being produced at lower massecuite purities. This is considered to be of practical importance since it should permit gauging of boiling operations so as to save some expensive remelting. In consideration of these facts the tenor of this report will be along the lines of pointing out what is being actually accomplished in the industry, with the idea that further investigation may lead to maintenance of sugar quality at reduced operating cost.

It was considered well at this time to change the form of Table IV, since but one factory produced sugar with ash above 0.020%. The new table presents the formula rating of Steffen and non-Steffen factories and the percent crystallization, boiling and centrifuging data of the white massecuites.

The average formula rating of Steffen factories is 66.41 and of non-Steffen factories is 73.84. The sugars from the Steffen factories have an average B-K turbidity index of 13.03, B-K color index of 8.87, and % ash x 10^3 of 11.64. The sugars from the non-Steffen factories have an average B-K turbidity index of 9.84, B-K color index of 6.12, and % ash x 10^3 of 10.32. Fourteen of sixteen factories having 50 per cent crystallization, or above, reported boiling their white massecuites below 85°C. and two factories reported boiling at 89° and 90°C. Here no exact correlation is found. The maximum per cent crystallization is found at 85°C. instead of at a lower temparature, and the several factories having the minimum per cent crystallization also reported boiling temperatures below 84°C. This seems to indicate that the per cent crystallization is not correlated closely, if at all, with the boiling temperature of the massecuite.

By referring to Table V, which gives the comparison of grain size, it is seen that all but three of the 15 factories showing 50 or more per cent crystallization have higher regularity of grain size than the average and less than the average amount of fine grain. The regularity of grain size is judged by adding the percentages collected on those two adjacent screens which retain the bulk of the sugar (for these sugars screens Nos. 40 and 50) and comparing this sum with the averages for these screens. The amount of fine grain was judged by adding to the sum of the percentages retained on the two last screens the percentage passed through the last screen and comparing with the averages for these at the foot of Table V. Two of the three factories having the lowest per cent crystallization show by the above method less regularity of grain size and a greater amount of fine grain than the average. It would seem that regularity of grain size and a smaller amount of fine grain correlates in the extremes with the per cent crystallization.

Comparing results in Table V for 1937 and 1938 by the above method it appears that slightly better results were achieved in 1937, when the per cent retained on the two adjacent screens, Nos. 40 and 50, averaged 69.16% against 68.15% in 1938. The fine grain, denoted by the per cent retained on the two last screens plus the per cent passed through the last screen, was 12.19% in 1937, as against 12.71% in 1938. It must be borne in mind that our data do not list any screening operations at the factory and that strike by strike operations may be regular in themselves but exhibit differences in a campaign composite sample. The amount of washing of the sugars also influences the regularity of grain size. For these reasons studies on regularity of grain should properly be made on the massecuites instead of on a campaign-composite sample of highly washed sugars.

Table VI presents the reflectance values of the sugars for the past five years. The average reflectance value for 1938 is 0.55 lower than for 1937. A possible explanation for this may be the fact that an average of 40.54% of the sugars was retained on screen 50 compared with 43.57% in 1937,

and an average of 27.61% of the sugars was retained on screen 40 compared with 25.59% in 1937. Or, simply stated, the predominant crystal size is larger in 1938 than in 1937.

Table VII and Figure I present the formula ratings of the sugars and purities of the white massecuites for the season and their averages. The average formula rating for all the sugars increased about 10 points over 1937. This gain is realized principally from improvement in the turbidity index, since the average ash and color index each improved less than one point. Nineteen Steffen factories have formula ratings above, and nineteen have formula ratings below, the average value for all the factories. As previously mentioned, the average formula rating for all the Steffen group is 3.66 points below that for all the factories.

The sugars from 28 of the non-Steffen factories have formula ratings above this year's average rating for all the factories and those from 10 factories have formula ratings below this average. Also in the non-Steffen group are sugars with an average formula rating 3.77 points above the average formula rating for all the factories.

It is interesting to note that two of the factories operating on the two-boiling system (see Figure I) have a formula rating for their sugars of 74.7 and 75.7, values which are 4.63 and 5.63 points above the average for all the factories. One of these factories is a non-Steffen and the other a Steffen factory.

Table No. VIII presents a comparison of the molasses worked, per cent on beets, in the same factories for the 1937 and 1938 campaigns in relation to the formula ratings of their sugars for these two years. The purities of the white massecuites are included for convenience. It is seen that the average per cent of molasses worked on beets is the same within 0.01% for the two years and that the average increase of one year compared with the other is also the same within 0.01%. In 1938, 15 factories show an increased formula rating of their sugars for a decrease in the per cent molasses worked on beets, the average increase being 16.82 points formula rating per one per cent decrease in molasses worked. However, 15 factories show an increase in formula rating of their sugars for an increased amount of molasses worked. The average increase in formula rating of the sugars from these factories is 10.99 points per one per cent increase in molasses worked.

In 1937 two factories showed an increased formula rating of their sugars for a decrease in the molasses worked, the average increase being 24.15 points per one per cent decrease in molasses worked. However, 3 factories in 1937 showed an increase in the formula rating of their sugars for an increase in the amount of molasses worked, the average increase in rating being 12.14 points per one per cent increase in the amount of molasses worked.

The sugars of the factory which has the maximum increase in molasses worked (5.03 percent on beets) and also the maximum amount of molasses worked (12.22 per cent on beets) show an increase of 4.7 points formula rating for the increased amounts of molasses worked.

Undoubtedly, the equipment and other factors regarding which we do not have data contribute to the fact that 18 factories have increased the molasses worked on beets without detrimental effect on quality of their sugars as indicated by formula rating.

In general, the sugars for this year show improvement in uniformity of quality. This fact is clearly shown by Figure I. It is realized that certain of the conclusions derived from the data we have secured are somewhat contrary to accepted thought, but they are presented as found, and to direct still more attention to the possibility of producing uniformly high quality sugar at a lower cost.

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TABLE I. - FACTORY DATA FOR BEET SUGAR SAMPLES, 1938 CAMPAIGN

Carbohydrate Res.Div. Number	Beets: Sugar	Beets: Apparent Purity	Diffusion juice apparent purity	CaO on beets	Molasses worked on beets	Method of carbonation: First	Method of carbonation: Second	Alkalinities and pH's: First carbonation	Alkalinities and pH's: Second carbonation	Alkalinities and pH's: Thin Juice	Alkalinities and pH's: Thick Juice	Alkalinities and pH's: First Liquor	Lime salts first liquor	SO_2 added: Thin Juice	Sulphur burned per ton beets	White Massecuite: Brix	White Massecuite: Apparent Purity	White Massecuite: pH	High wash apparent purity	High green apparent purity	Remelt sugars apparent purity: High	Remelt sugars apparent purity: Low	Centrifugal Wash Water: Temperature	Centrifugal Wash Water: Quarts per machine	Centrifugal Wash Water: Qts.per 100 lbs. sugar sacked	Filter aid used	Carbon used	Filtration data 1st liquor: Brix	Filtration data 1st liquor: Temperature	Temperature sugar as sacked
	Percent			Percent	Percent										Pounds						High	Low	°C.						°C.	°C.
3801	16.03	81.0	82.6	4.81	6.75	Batch	Batch	0.066	0.025	—	—	7.5	0.197	No	0.55	91.5	89.6	7.3	86.3	80.7	98.0	94.5	90.0	16.0	5.0	Yes	No	61.0	75	47
3802	15.89	81.01	83.4	5.47	6.89	"	"	.054	.014	8.7	8.6	8.2	.129	No	.20	90.3	91.0	7.9	87.3	81.5	98.14	97.41	90.0	18.0	6.07	Yes	No	65.0	93.5	46
3803	16.18	83.50	84.4	2.29	N.S.	"	Cont.	.078	8.4	9.0	---	9.2	.037	Yes	.21	92.0	93.2	9.0	93.8	87.5	97.9	91.0	91.0	14.7	4.9	Yes	Yes	63.2	94.0	49
3804	16.23	84.70	85.7	2.50	N.S.	"	Batch	.070	.005	8.2	7.7	7.3	.065	No	.37	91.5	89.5	7.3	85.5	77.5	91.81	89.73	83	15	5.4	Yes	No	65.76	85	47
3805	16.34	81.4	85.1	5.36	9.02	Cont..	Cont.	.084	.022	8.4	8.2	8.1	.093	Yes	.18	90.7	92.3	8.2	89.6	86.0	96.5	94.8	89	16	5.8	Yes	Yes	93.0	95	49
3806	16.93	81.5	80.9	5.41	7.67	Cont.	Cont.	11.27	9.23	8.79	8.59	8.46	.035	Yes	.75	91.7	90.4	8.38	88.6	83.5	97.8	95.1	86	16	5.0	Yes	No	67	85	46
3807	16.27	84.03	85.86	4.44	5.02	Batch	Batch	.083	.026	8.6	8.5	8.2	.122	Yes	.449	91.2	92.0	7.9	88.9	82.9	98.4	96.9	85	14	4.66	Yes	No	62.5	98	53
3808	17.16	82.77	85.68	2.79	N.S.	Cont.	Cont.	11.36	9.10	8.68	8.88	8.7	.032	Yes	.17	92.26	92.98	8.86	92.27	86.19	98.46	95.87	86	12	4.3	Yes	No	70.46	95	50.4
3809	17.54	86.20	86.6	2.7	N.S.	"	"	11.1	9.4	8.0	7.9	7.9	.035	Yes	.64	92.20	93.0	7.9	95.0	86.8	98.7	95.2	90	18	6.0	Yes	Yes	68	85	48
3810	15.01	83.04	84.19	2.9	5.28	Batch	Cont.	.056	.018	8.18	7.98	8.12	.163	Yes	.30	90.79	90.55	7.81	92.27	83.6	97.78	94.46	79	17	5.23	Yes	Yes	65	87	56.3
3811	14.98	82.4	84.41	2.25	N.S.	Batch	Cont.	.084	.013	---	.096	8.2	.051	No	.34	92.83	86.75	8.2	82.18	74.27	---	94.30	90	18	7.0	Yes	No	62.33	95	56
3812	17.61	84.31	85.0	4.50	4.649	Batch	Batch	.064	9.07	---	---	8.3	.049	No	.33	91.80	89.60	8.04	86.26	78.2	---	93.30	85	16.5	5.58	Yes	No	61.40	91.1	71.9
3813	15.01	87.1	87.1	3.35	5.710	Batch	Cont.	.079	9.10	8.2	9.6	8.4	.007	Yes	.50	90.20	91.0	8.7	88.70	83.8	95.5	84.7	92	19	5.4	Yes	No	68.2	93.0	43
3814	17.30	85.0	86.7	4.23	7.93	Cont.	Cont.	11.2	8.7	7.9	7.7	7.9	.081	Yes	.32	91.60	93.2	8.0	92.20	86.9	98.0	95.2	80	15	5.0	Yes	No	69.0	96.0	48
3815	17.75	85.8	87.0	6.32	12.22	Cont.	Cont.	11.1	9.1	7.9	7.6	7.6	.038	Yes	.76	89.8	92.4	7.4	87.9		99.1	93.6	90	16	5.1	Yes	Yes	66.4	95.0	51
3816	15.73	82.64	85.90	2.35	N.S.	Batch	Cont.	.070	.011	7.2	7.4	---	.065	Yes	.60	92.77	87.45	7.4	83.56	74.84	95.59	---	83	22	6.0	Yes	Yes	54.92	95.0	55
3817	17.41	84.35	86.41	3.91	5.94	Batch	Batch	.096	.017	8.5	8.6	7.7	.053	Yes	.37	92.0	91.30	7.5	90.60	83.40	96.90	96.60	93	14	5.4	Yes	Yes	64.9	100.0	—
3818	16.26	87.30	88.40	4.54	6.91	Cont.	Cont.	.081	.014	8.5	---	8.0	.025	Yes	.53	91.0	92.70	8.2	90.30	87.0	97.2	94.30	92	16	6.3	Yes	Yes	70.0	83	55
3819	15.61	80.18	83.10	3.5	N.S.	Batch	Batch	.095	.020	8.7	9.2	8.4	.071	No	.27	92.6	91.70	8.5	91.90	85.9	99.4	97.0	90	16	8.0	Yes	Yes	57.4	95	64
3820	16.14	88.03	89.9	2.83	6.43	Batch	Cont.	.060	.017	8.0	8.1	8.2	.036	Yes	.39	91.1	94.2	7.5	90.80	86.9	96.8	92.9	93	17	7.0	Yes	No	65.5	94	38
3821	17.21	80.97	86.7	2.50	N.S.	Batch	Cont.	.096	8.8	8.7	8.8	8.7	.056	No	.41	92.1	91.3	8.5	87.8	82.6	98.0	96.8	84	14.2	4.5	Yes	Yes	60.3	95	42
3822	15.39	—	87.4	1.38	N.S.	"	"	.080	9.3	8.0	8.5	8.4	.017	Yes	.68	91.2	90.7	8.4	89.0	81.5	97.3	87.2	90	16.0	5.4	Yes	No	71.7	90	44
3823	15.49	—	87.7	1.47	N.S.	Batch	Batch	.087	9.2	8.0	8.5	8.6	.018	Yes	.73	92.2	90.5	8.5	88.4	82.1	97.4	83.3	91	15.0	6.0	Yes	No	71.7	90	38
3824	18.18	86.3	88.5	2.25	N.S.	Batch	Batch	.105	.019	8.6	8.9	8.4	.028	Yes	.39	91.6	92.8	8.5	94.0	85.5	98.2	93.0	85	17.1	5.0	Yes	Yes	62.3	90	35
3825	17.44	83.83	86.9	5.47	6.49	Cont.	Cont.	.091	8.8	8.8	8.6	7.7	.101	No	.523	91.3	92.1	7.5	91.3	84.1	97.9	96.5	87	15.4	---	Yes	Yes	61.5	98	43.8
3826	17.71	85.7	86.8	2.46	N.S.	Batch	Batch	.098	.036	---	0.114	7.9	---	No	.35	92.6	89.6	7.8	86.3	77.7	—	93.7	88	18	3.0	Yes	No	60	95	58
3827	17.54	86.35	87.30	2.50	N.S.	"	"	.725	.004	7.57	---	8.45	.097	Yes	.45	90.07	90.39	8.37	88.67	83.54	96.25	92.76	80	15	—	Yes	No	55	95	68
3828	15.22	86.83	87.80	2.79	N.S.	"	Cont.	.084	.015	8.4	8.4	8.4	.023	Yes	.34	91.10	92.90	8.3	91.9	86.9	97.2	91.9	90	14.1	2.9	Yes	No	64.8	92	65
3829	15.22	86.62	86.90	1.90	N.S.	"	Cont.	.082	.017	8.1	8.7	8.7	.030	Yes	.46	91.90	91.10	8.1	89.6	84.4	96.4	89.0	91	14	9.5	Yes	Yes	66.5	92	66
3830	14.81	83.36	84.54	2.33	N.S.	"	Cont.	.095	.019	8.6	9.7	8.7	.015	Yes	.67	91.9	91.0	8.8	90.7	83.8	98.6	91.2	93	18	7.4	Yes	Yes	66.3	91	34
3831	15.88	85.0	86.8	2.07	N.S.	Batch	Cont.	.090	.018	8.0	9.1	8.5	.034	Yes	.50	92.3	91.0	8.5	89.7	83.4	98.4	91.5	90	19	6.9	Yes	Yes	68.1	94	53
3832	14.07	83.4	82.9	3.86	8.53	"	"	.076	.010	7.6	7.0	8.0	.133	Yes	.49	90.8	91.3	7.4	92.8	83.2	99.1	91.7	88	17	—	Yes	Yes	66.0	68.4	45
3833	14.99	83.8	84.0	5.29	7.59	Cont.	"	.095	8.4	8.4	—	8.7	.029	Yes	.75	90.2	93.6	8.6	92.0	87.5	98.8	95.2	95	16	6.5	Yes	Yes	67	90	54
3834	14.33	—	84.0	2.68	4.74	"	"	.071	9.4	7.5	8.0	8.1	.013	Yes	.64	91.7	90.4	8.3	88.8	82.1	96.7	83.1	86	14	6.0	Yes	No	66.2	92	41
3835	17.4	83.78	85.96	2.82	N.S.	Batch	Batch	11.1	8.8	8.8	8.8	8.5	.048	Yes	.256	91.3	91.0	8.1	87.9	82.6	98.1	95.8	85	14	5.4	Yes	Yes	65.6	90	47

TABLE I. - FACTORY DATA FOR BEET SUGAR SAMPLES, 1938 CAMPAIGN (CONTINUED)

Carbohydrate Res.Div. Number	Beets: Sugar	Beets: Apparent Purity	Diffusion juice apparent Purity	CaO on beets	Molasses worked on beets	Method of carbonation: First	Method of carbonation: Second	Alkalinities and pH's: First carbonation	Alkalinities and pH's: Second carbonation	Alkalinities and pH's: Thin Juice	Alkalinities and pH's: Thick Juice	Alkalinities and pH's: First Liquor	Lime salts first liquor	SO_2 added: Thin Juices	SO_2 added: Thick Juices	Sulphur burned per ton beets	White Massecuite: Brix	White Massecuite: Apparent Purity	White Massecuite: pH	High wash apparent purity	High green apparent purity	Remelt sugars apparent purity: High	Remelt sugars apparent purity: Low	Centrifugal Wash Water: Temperature	Centrifugal Wash Water: Quarts per machines	Centrifugal Wash Water: Qts.per 100 lbs. sugar sacked	Filter aid use	Carbon used	Filtration data 1st liquor: Brix	Filtration data 1st liquor: Temperature	Temperature sugars as sacked
	Percent			Percent	Percent											Pounds								°C						°C	°C
3836	15.68	87.26	89.00	2.54	N.S.	Batch	Cont.	.079	.013	7.9	9.3	9.2	.017	Yes	No	.42	92.0	92.0	9.3	90.1	86.4	97.1	92.2	94	15.4	7	Yes	Yes	67.6	94	43
3837	16.35	87.40	88.9	2.67	N.S.	"	"	.087	9.0	8.4	9.1	7.8	.021	Yes	Yes	.69	91.6	93.2	7.7	91.4	86.8	96.2	91.8	86	14.9	4.4	Yes	No	70.5	96	49
3838	18.03	85.50	86.3	3.62	6.54	"	"	.072	8.9	8.7	8.7	8.6	.028	Yes	No	.24	91.9	94.9	8.6	94.1	89.5	99.5	94.7	92	17	5	Yes	Yes	71.4	74	42
3839	16.97	83.40	87.2	4.01	7.07	Cont.	"	11.5	8.8	7.9	7.9	7.9	.068	Yes	No	.23	92.0	92.4	7.7	93.0	84.8	97.9	95.6	90	17	3.9	Yes	No	66.3	90	27
3840	15.10	---	86.9	3.78	6.64	"	"	.084	8.9	7.6	8.2	8.4	.026	Yes	No	.55	92.3	91.9	8.2	91.4	84.7	97.0	88.6	90	16	4.0	Yes	No	69.3	98	31
3841	15.33	86.3	87.3	4.59	6.63	Batch	Cont.	.070	.020	7.5	8.0	8.0	.027	Yes	No	.69	90.5	93.1	7.6	92.0	87.4	98.4	93.7	91	18	---	Yes	Yes	72.0	93	41
3842	16.32	84.2	86.6	3.70	5.59	"	"	11.1	8.6	8.1	---	7.9	.033	Yes	Yes	.70	91.2	91.7	7.7	89.4	85.5	97.4	92.5	81	15	6.0	Yes	No.	91.7	92	70
3843	16.12	83.6	84.9	4.30	5.78	Cont.	"	.083	8.3	8.0	8.5	8.5	.036	Yes	No	.34	90.4	92.6	8.5	90.5	85.1	99.1	96.9	94	17	5.7	Yes	Yes	65.8	94	53
3844	16.55	83.03	85.8	4.39	6.11	"	"	.083	9.2	9.2	9.0	8.7	.067	No	Yes	.26	90.2	92.5	8.5	90.2	85.5	98.2	92.4	89	16	4.6	Yes	Yes	66	93	57
3845	15.84	84.50	85.8	1.86	N.S.	Batch	"	.084	8.7	8.7	10.0	8.5	.013	No	Yes	.50	92.8	92.1	8.8	89.6	84.8	98.1	89.8	94	14	4.2	Yes	Yes	66.6	94	46
3846	15.24	86.5	86.5	1.49	N.S.	Batch	Cont.	.087	9.2	7.9	8.0	8.3	.023	Yes	No	.65	91.9	90.9	8.1	89.8	81.7	97.5	87.7	86	14	2.0	Yes	No	65.8	90	31
3847	15.30	85.99	87.9	2.70	7.06	Cont.	"	.065	.014	8.1	8.5	8.5	.041	Yes	No	.37	91.6	92.7	8.1	90.8	87.2	96.9	93.9	89	16	5.0	Yes	No	60.7	92	30
3848	15.71	85.2	86.5	3.73	5.57	"	"	.074	8.9	8.4	---	8.4	.030	Yes	—	.42	91.1	91.9	8.4	91.1	85.6	96.8	91.7	96	14	5.1	Yes	No	65.4	94	54
3849	15.81	85.1	89.0	2.00	N.S.	Batch	"	.078	8.7	8.1	9.4	9.3	.040	Yes	No	.36	91.1	92.2	9.3	90.0	85.5	97.9	93.1	91	14.8	6.8	Yes	Yes	67.5	92	68
3850	15.46	85.8	88.1	3.54	5.87	Cont.	"	.074	.015	7.6	7.1	7.0	—	Yes	No	.56	90.2	91.5	7.1	89.8	85.6	95.8	90.1	91	17.5	5.0	Yes	Yes	62.3	90	35
3851	17.21	---	88.3	1.44	N.S.	Batch	Cont.	.079	9.2	7.8	8.3	8.4	.016	Yes	No	.58	90.8	91.8	8.3	90.6	86.3	97.7	86.4	89	14	4.5	Yes	Yes	69.6	85	48
3852	16.83	89.2	89.9	2.25	N.S.	"	"	.067	.02	7.7	8.2	8.3	.008	Yes	No	.82	91.3	94.2	8.1	93.6	88.6	98.9	92.1	90	18	6.0	Yes	Yes	—	—	51
3853	17.74	83.2	84.7	2.47	N.S.	"	"	.088	.031	8.5	8.0	7.7	.042	Yes	Ye	.59	91.8	90.8	7.3	92.3	81.4	99.0	93.2	90	18	5.18	Yes	Yes	68.1	92	47
3854	16.32	84.29	86.3	2.75	N.S.	"	"	.086	8.7	8.3	8.9	8.9	.020	Yes	No	.71	91.3	92.1	8.9	91.7	85.5	97.8	89.9	90	13	5.2	Yes	Yes	70.1	95	64
3855	15.06	85.17	86.5	4.3	6.95	Batch	"	.070	.013	8.2	8.4	8.4	.064	Yes	No	.42	91.0	91.8	7.5	89.5	85.5	97.5	91.6	91	14	5.87	Yes	Yes	64.9	95	41
3856	15.59	86.4	87.3	3.57	4.00	Cont.	Cont.	.072	.018	7.9	7.5	7.5	.043	Yes	No	.52	91.7	92.4	7.4	91.8	86.0	97.5	94.4	93	18	6.0	Yes	Yes	71.2	88	48
3857	15.37	83.5	84.0	2.29	N.S.	Batch	"	.086	.025	8.4	7.9	7.7	.074	Yes	Ye	.73	90.9	92.0	7.3	92.3	85.7	99.2	94.5	84	19	6.0	Yes	Yes	67.6	—	45
3858	15.00	76.6	79.5	4.63	8.14	"	"	.06	8.2	7.9	9.1	7.6	.025	No	Ye	.30	92.4	88.4	7.6	87.3	81.9	96.3	90.9	85	20	8.0	Yes	Yes	64.1	92	52
3859	15.72	86.9	88.9	2.03	N.S.	"	"	.06	.017	7.9	7.9	8.0	—	Yes	No	.52	91.4	91.3	7.6	90.0	85.1	95.2	92.0	90	12	3.0	Yes	Yes	70.6	89	49
3860	14.98	---	85.4	3.57	6.61	Batch	"	.072	9.3	7.9	8.4	8.5	.018	Yes	No	.58	92.3	90.1	8.3	87.6	82.0	97.5	88.4	85	14	5.6	Yes	No	69.2	90	50
3861	15.49	86.3	87.8	2.28	N.S.	Cont.	Cont.	.074	.015	7.3	7.4	7.5	--	Yes	No	.64	92.20	90.5	7.3	88.0	84.2	96.7	93.2	85	9	5.0	Yes	Yes	68.7	90	61
3862	16.48	82.79	85.3	2.69	N.S.	Batch	Batch	.111	.022	8.6	8.9	8.7	.023	Yes	Ye	.39	90.2	92.9	8.7	93.8	86.8	97.9	92.9	94	16	6.0	Yes	Yes	67.6	91	47
3863	15.41	86.30	88.0	3.32	6.63	Cont.	Cont.	.066	.013	7.9	7.5	7.4	.025	Yes	No	.37	91.3	92.2	7.4	90.0	86.6	98.2	93.6	88	16	9.0	Yes	Yes	70.1	91	50
3864	14.85	86.10	86.10	3.29	6.06	Batch	"	.064	9.2	8.0	8.6	8.5	.014	Yes	--	.72	91.0	90.6	8.6	87.7	83.4	97.6	92.2	86	14.5	5.0	Yes	Yes	69.2	87	50
3865	15.23	---	87.7	--	N.S.	Batch	"	.075	9.1	7.7	9.0	8.9	.025	Yes	No	.77	91.4	90.3	9.0	87.9	81.1	96.2	85.1	83	16	4.6	Yes	No	68.3	89.	45
3866	15.77	86.7	89.0	2.09	N.S.	Batch	Batch	.069	.014	7.5	7.3	7.2	---	Yes	No	.68	91.7	92.4	7.2	89.1	85.9	97.3	91.9	84	10	3.3	Yes	Yes	68.9	87	84
3867	16.27	81.3	82.0	4.66	9.04	Cont.	Cont.	.091	9.0	8.3	7.3	7.3	.129	Yes	No	.45	91.5	90.8	7.1	87.7	83.0	98.4	94.0	92	13	5.04	Yes	Yes	68.9	95	50
3868	18.67	84.0	85.2	2.92	N.S.	Cont.	Cont.	.085	8.6	7.8	7.8	7.8	.065	Yes	No	.50	91.0	91.7	7.4	98.5	84.2	98.8	94.6	90	12	5.59	Yes	Yes	71.5	96	58
3869	15.74	84.5	84.2	3.83	5.58	Cont.	Cont.	11.7	9.2	9.3	---	9.4	.055	Yes	No	.17	92.7	92.7	8.8	92.4	85.7	98.4	93.7	93	20	7.0	Yes	Yes	70.8	92	46
3870	16.58	86.6	87.9	3.68	5.83	Cont.	Cont.	.082	8.8	8.3	---	7.5	.036	Yes	Ye	.53	91.1	92.3	7.7	88.5	86.4	97.0	92.7	93	15	3.75	Yes	No	61.1	98	54
3871	15.25	86.7	87.9	2.21	N.S.	Cont.	Cont.	.085	.014	7.5	8.7	8.6	.047	Yes	No	.45	92.2	91.5	8.8	88.2	84.6	95.8	90.3	90	16	6	Yes	Yes	59.6	85	60
3872	14.78	81.2	81.9	3.46	6.43	Batch	"	.072	.021	8.1	7.6	7.6	.093	Yes	No	.50	90.3	90.6	7.5	89.3	80.9	99.3	92.9	89	18	---	Yes	Yes	64.4	89	61
3873	15.295	85.80	87.41	2.83	N.S.	Cont.	"	.073	.017	8.4	8.4	8.3	.047	Yes	No	.299	92.1	93.5	8.4	91.4	87.2	98.0	92.1	95	12.7	4.5	Yes	Yes	65.37	91	51
3874	16.56	84.8	86.2	2.23	N.S.	"	"	.084	8.7	7.7	8.3	7.8	.020	Yes	---	.58	91.0	92.8	7.8	89.3	84.9	97.1	91.9	90	16	5.5	Yes	Yes	70.6	98	53
3875	17.021	83.44	86.6	2.66	N.S.	"	"	.095	.018	8.0	9.1	9.1	.035	Yes	No	.51	91.5	91.8	9.0	90.0	84.4	97.3	90.3	91	15	5.0	Yes	Yes	65.5	93	52
3876	15.647	86.49	89.81	---	6.49	Batch	Cont.	.074	.013	8.0	8.2	8.1	.032	Yes	No	.35	90.3	93.6	8.0	91.8	89.1	97.7	92.8	91.	14	---	Yes	No	59.4	95	31

ds 6/21/39

TABLE II -- ANALYTICAL DATA ON BEET SUGAR SAMPLES, 1938 CAMPAIGN

Carbo-hydrate Div.No.	Foaming	Color B-K	pH	Turbidity	B-K	Ash	SO_3	Total SO_2	Cl	CaO	Na_2O	K_2O	Barley Candy Color B-K	pH	Invert Sugar	Sucrose
	cc.	index		-log t	index	Percent	p/m	p/m	p/m	p/m	p/m	p/m	index		Percent	Percent
3801	90-80	13.3	6.9	0.00975	17.1	0.0180	27	5	5	20	7	67	24.1	4.9	1.75	96.89
3802	95-75	12.4	7.1	0.01071	18.6	0.0120	4	4	5	10	9	24	17.2	4.8	1.56	97.04
3803	90-70	5.8	6.8	0.00278	5.2	0.0070	Trace	4	6	11	10	5	11.4	4.6	1.84	96.59
3804	100-85	5.6	7.0	0.01137	19.6	0.0110	9	19	9	7	8	18	16.5	4.7	1.70	96.59
3805	90-70	12.8	6.9	0.00705	12.7	0.0100	7	3	9	15	9	13	18.1	4.7	1.98	95.98
3806	100-75	7.4	7.1	0.00519	9.5	0.0120	13	11	21	10	25	19	16.8	4.8	1.72	96.59
3807	90-70	11.0	7.0	0.00858	15.2	0.0070	4	4	6	8	10	18	17.1	4.7	2.05	95.98
3808	85-70	7.8	6.9	0.00242	4.6	0.0058	1	3	11	7	9	8	12.0	4.8	1.68	96.44
3809	95-70	4.4	6.8	0.00492	9.0	0.0070	8	16	12	8	11	2	17.8	4.7	1.89	96.29
3810	115-80	10.7	7.0	0.00801	14.4	0.0090	14	6	8	11	7	22	18.1	4.7	1.62	96.59
3811	100-85	6.6	7.1	0.00360	6.7	0.0120	6	10	4	6	7	33	10.8	4.7	1.64	96.59
3812	115-95	6.7	7.0	0.00324	6.1	0.0115	5	9	8	8	9	25	15.9	4.7	1.56	97.04
3813	125-85	3.7	6.9	0.00492	9.0	0.0120	7	11	7	6	8	42	12.9	4.6	1.79	96.29
3814	125-90	9.3	6.8	0.00283	5.3	0.0090	5	4	6	8	10	20	14.3	4.7	1.64	96.59
3815	100-85	6.2	7.0	0.00298	5.6	0.0105	2	12	6	8	16	17	13.2	4.9	1.58	96.74
3816	125-100	7.6	7.0	0.01193	20.5	0.0125	1	34	16	17	7	35	15.9	4.7	1.42	96.89
3817	100-85	7.3	7.1	0.00340	6.3	0.0085	4	4	5	9	7	22	15.6	4.8	1.72	96.44
3818	105-100	6.0	6.9	0.00605	11.0	0.0120	3	16	10	8	10	36	13.7	4.7	1.46	97.19
3819	90-75	4.6	7.0	0.00300	5.5	0.0075	Trace	12	7	7	4	28	13.5	4.7	2.05	95.83
3820	105-85	5.5	6.9	0.00278	5.2	0.0110	2	9	6	5	5	24	15.6	4.7	1.64	96.74
3821	90-75	7.8	7.0	0.00324	6.0	0.0050	2	3	3	6	1	9	13.6	4.7	1.73	96.89
3822	120-85	3.3	6.9	0.00740	13.3	0.0085	3	19	13	5	6	20	11.8	4.8	1.56	96.44
3823	120-85	5.3	7.1	0.00429	8.0	0.0105	10	22	13	5	10	35	14.3	4.8	1.37	97.65
3824	90-70	8.2	7.0	0.00595	10.8	0.0120	2	8	6	7	5	42	17.3	4.7	1.45	96.89
3825	95-75	16.2	6.9	0.01193	20.5	0.0090	2	3	5	12	10	19	16.7	4.8	1.58	97.04
3826	95-75	5.8	7.0	0.00870	15.4	0.0085	5	15	7	9	5	21	16.4	4.9	1.28	97.80
3827	95-80	6.2	7.1	0.00811	14.5	0.0080	10	8	4	9	3	27	15.1	4.8	1.70	96.59
3828	105-85	6.6	7.0	0.00371	6.9	0.0100	11	9	6	6	4	32	14.4	4.8	1.56	96.89
3829	95-80	7.4	7.1	0.00381	7.1	0.0150	13	7	29	3	12	60	15.4	4.7	1.28	97.50
3830	95-85	5.2	7.0	0.00319	6.0	0.0120	10	12	14	2	10	16	14.3	4.7	1.38	97.19
3831	95-75	6.3	7.1	0.00864	15.3	0.0125	7	13	21	5	8	41	13.1	4.8	1.42	97.04
3832	95-85	6.7	7.0	0.00263	5.0	0.0070	2	4	2	7	4	7	11.7	4.9	1.75	96.44
3833	105-90	4.4	7.1	0.00397	7.4	0.0125	10	10	6	11	13	28	12.8	4.8	1.02	98.25
3834	100-85	2.9	7.0	0.00147	2.8	0.0100	5	16	13	5	9	33	12.4	4.7	1.58	96.44
3835	90-80	5.3	7.0	0.00182	3.5	0.0070	1	6	3	7	2	13	14.3	4.9	1.46	97.04
3836	105-85	5.9	7.1	0.00529	9.7	0.0120	8	4	5	7	2	39	14.1	4.7	1.37	97.38
3837	120-80	1.1	6.8	0.00293	5.5	0.0125	12	35	8	10	5	59	14.8	4.7	1.64	96.59
3838	100-80	3.2	7.1	0.00192	3.7	0.0070	2	4	5	10	6	9	10.0	4.8	1.58	96.74
3839	100-85	7.7	7.0	0.00207	3.9	0.0080	3	4	9	10	6	15	11.8	4.8	1.45	96.89
3840	95-80	4.2	7.1	0.00147	2.8	0.0126	6	16	11	7	5	25	13.7	4.7	1.56	97.04

ds 6/21/39

TABLE II--ANALYTICAL DATA ON BEET SUGAR SAMPLES, 1938 CAMPAIGN (CONTINUED)

Carbohydrate Div.No.	Foaming	Color B-K	pH	Turbidity		Ash	SO_3	Total SO_2		CaO	Na_2O	K_2O	Barley Candy			
					B-K								Color B-K	ph	Invert Sugar	Sucrose
	cc.	index		-log t	index	Percent	p/m	p/m	p/m	p/m	p/m	p/m	index		Percent	Percent
3841	100-80	5.7	7.1	0.00471	8.7	0.0160	17	29	7	7	21	56	15.3	4.7	1.68	96.89
3842	105-85	3.1	7.0	0.00182	3.5	0.0100	9	20	4	8	7	37	14.3	4.9	1.45	97.04
3843	90-80	9.5	7.2	0.01053	18.3	0.0095	5	5	2	3	2	34	16.4	4.7	1.64	96.89
3844	85-70	11.8	7.1	0.00600	10.9	0.0095	2	5	4	13	7	14	16.8	4.7	1.74	96.59
3845	145-85	2.8	7.1	0.00143	2.7	0.0115	13	13	4	7	10	27	13.8	4.8	1.37	97.50
3846	100-80	3.4	7.0	0.00147	2.8	0.0095	10	20	2	5	5	15	10.2	4.7	1.62	96.89
3847	95-80	10.4	7.0	0.00722	13.0	0.0110	Trace	6	4	13	9	31	12.7	4.7	1.78	96.74
3848	100-90	4.9	7.1	0.00503	9.2	0.0105	3	11	9	8	5	20	12.0	4.8	1.44	97.04
3849	100-80	6.6	7.0	0.00298	5.6	0.0100	5	5	4	8	1	32	14.1	4.8	1.73	96.44
3850	90-85	8.6	7.0	0.00773	13.8	0.0120	3	22	9	8	7	26	14.6	4.8	2.05	95.68
3851	110-80	2.1	7.1	0.00172	3.3	0.0095	3	11	1	6	4	17	9.6	4.7	1.58	97.04
3852	95-75	7.0	6.9	0.00964	16.9	0.0115	3	33	6	5	2	39	14.1	4.8	1.56	97.04
3853	120-100	4.4	7.0	0.00339	6.4	0.0110	2	14	7	7	3	6	13.4	4.8	1.44	97.35
3854	125-80	8.1	7.2	0.00350	6.6	0.0115	9	6	2	4	5	32	14.0	4.9	1.68	96.74
3855	105-95	8.0	7.0	0.00503	9.3	0.0140	8	5	7	13	14	36	14.2	4.6	1.28	97.65
3856*	90-75	20.1	7.1	0.02579	38.7	0.0115	1	12	6	6	8	17	19.4	4.8	1.75	96.59
3857	100-80	5.6	7.0	0.00661	12.0	0.0070	4	11	5	6	3	--	11.6	5.0	1.70	96.59
3858	105-85	12.2	7.0	0.00969	17.0	0.0330	70	7	6	10	18	115	17.8	4.9	1.63	96.89
3859	95-80	8.0	6.8	0.01137	19.6	0.0200	7	34	4	4	2	82	20.1	4.8	1.68	96.74
3860	100-85	5.0	7.1	0.00319	6.0	0.0110	2	15	7	4	2	42	13.7	4.7	1.65	96.89
3861	95-75	7.8	6.9	0.01193	20.5	0.0160	6	37	4	5	11	45	16.3	4.8	2.20	95.53
3862	95-80	6.3	7.1	0.00552	10.1	0.0085	2	6	3	5	—	2	12.8	4.6	1.75	96.74
3863	90-70	22.0	7.0	0.02497	37.8	0.0120	1	7	4	8	4	39	23.0	4.8	2.26	95.53
3864	105-80	11.8	7.0	0.03472	48.0	0.0140	13	14	6	8	7	47	14.0	4.7	1.56	96.44
3865	110-85	4.1	7.1	0.00192	3.6	0.0095	22	9	5	5	2	33	10.8	5.0	1.63	96.44
3866	95-75	10.4	6.9	0.01180	20.3	0.0200	21	33	7	5	7	91	19.9	4.6	1.84	96.13
3867	90-80	11.0	7.0	0.00355	6.6	0.0080	2	3	9	8	14	11	12.1	4.7	1.56	96.44
3868	95-85	7.3	7.0	0.00402	7.5	0.0055	8	5	7	6	5	2	8.9	4.8	1.42	96.74
3869	90-75	10.4	7.0	0.01939	30.9	0.0108	10	3	4	17	10	2	12.4	5.0	1.98	95.98
3870	120-100	7.3	6.9	0.00402	7.5	0.0190	11	13	0	9	11	40	16.4	4.9	1.61	96.59
3871	100-85	10.2	7.1	0.00916	16.7	0.0125	12	7	5	9	12	27	9.3	4.7	1.46	96.89
3872	90-85	11.7	6.9	0.01243	21.2	0.0133	22	9	6	7	7	12	17.5	5.0	1.55	96.74
3873	95-80	5.0	7.1	0.00257	4.9	0.0060	6	6	2	5	3	1	11.6	4.9	1.84	96.29
3874	115-90	5.0	6.9	0.00207	3.9	0.0085	9	19	7	4	4	15	12.0	4.8	1.92	96.13
3875	110-85	9.9	7.1	0.00750	13.5	0.0090	14	6	3	5	5	18	15.8	4.7	1.61	96.89
3876	110-100	8.2	7.1	0.00661	12.9	0.0087	12	9	3	6	3	15	12.5	4.7	1.76	96.74
3877**	100-75	4.2	7.3	0.00247	4.7	0.0115	3	3	1	3	28	7	12.4	4.7	1.84	96.29
Averages																
1938-39	101-82	7.5	7.0	0.00656	11.4	0.0109	7.8	11.5	9.5	7.8	7.3	27.7	14.5	4.76	1.64	96.73
1937-38	98-83	8.16	6.9	0.01128	19.76	0.0116	15.1	12.4	11.8	8.4	11.0	32.3	13.5	4.7	1.75	96.24
1936-37	92-71	9.4	6.8	0.01159	20.5	0.0135	14.1	12.4	6.2	8.5	13.3	43.2	13.9	5.0	1.18	96.95
1935-36	83-72	10.3	6.8	0.01482	24.6	0.0132	6.3	13.7	6.6	8.5	11.0	49.3	—	5.0	1.19	96.46
1934-35	84-73	—	6.8	0.01949	—	0.0140	15.6	16.5	5.8	8.4	9.6	41.3	—	4.9	1.07	96.36
1933-34	88-72	—	6.8	0.01938	—	0.0197	21.7	25.4	4.0	12.3	10.8	64.9	—	4.8	1.53	96.67
1932-33	90-72	—	6.8	0.01863	—	0.0245	22.4	26.6	3.0	16.0	25.5	102.6	—	4.7	1.42	96.09
1931-32	96-65	—	6.8	0.02245	—	0.0274	49.9	25.1	6.6	16.5	—	—	—	4.7	1.20	96.27
1930-31	90-65	—	6.9	0.03191	—	0.0389	95.5	23.2	—	—	—	—	—	4.7	1.43	95.91
1929-30	125-68	—	6.9	0.06+	—	0.0427	—	—	—	—	—	—	—	4.5	1.60	—

* Solution Milky
** Not included in averages (special sugar)

ds 5/17/39

TABLE III - COMPARATIVE DATA FO 930, 1931, 1932, 1933, 1934, 1935, 1936, 1937 and 1938.

Factory	Apparent Purity of White Massecuite									Turbidity, -log t x 10^5									Ash, % x 10^3									Sulfates p/m								
	1930	1931	1932	1933	1934	1935	1936	1937	1938	1930	1931	1932	1933	1934	1935	936	1937	1938	1930	1931	1932	1933	1934	1935	1936	1937	1938	1930	1931	1932	1933	1934	1935	1936	1937	1938
A	82.0	84.4	83.7	85.0	90.2	90.0	90.6	90.7	90.6	1706	3343	1525	1008	3230	1176	07	2041	1243	193	34	60	24	18	15	15	11	13	873	54	149	43	8	0	22	17	22
B	81.5	83.1	84.9	85.0	90.4	92.6	91.9	92.2	93.1	5943	4067	2479	603	1798	925	46	688	471	254	61	32	30	17	19	23	19	16	1188	160	36	29	13	18	27	19	17
C	84.1	83.6	86.3	86.3	88.1	90.1	90.0	89.5	90.1	2686	2378	373	3230	525	763	82	648	319	89	58	25	20	15	11	15	10	11	360	235	22	43	18	3	19	19	2
D	83.0	84.9	85.7	86.9	88.5	90.3	90.4	90.6	90.6	3819	1522	2179	1615	1091	448	13	1707	3472	95	42	36	26	21	16	19	17	14	357	85	39	23	17	1	41	20	13
E	85.5	87.4	87.8	87.6	88.3	90.4	90.4	90.8	91.0	2791	2476	1892	1892	1348	1436	20	975	492	98	32	25	35	30	12	14	12	12	309	27	3	23	21	0	10	21	7
F	87.0	86.6	87.5	88.1	91.1	92.4	92.3	92.1	92.70	2179	4733	3118	3007	3943	843	87	789	605	124	50	81	22	39	13	12	10	12	471	149	307	38	246	0	12	16	3
G	84.7	86.2	86.0	85.5	89.0	91.6	91.4	93.1	93.60	3344	2896	2278	1615	2376	1008	44	578	397	40	47	26	36	32	15	17	12	13	105	191	26	127	129	2	20	21	10
H	89.8	90.2	90.4	90.0	90.9	91.9	92.4	93.6	94.20	1615	1173	146	763	1262	1892	82	882	964	17	19	14	15	14	11	12	12	12	2	11	0	3	0	0	22	17	3
J	----	83.6	86.0	89.6	91.2	91.2	90.8	91.9	92.40	1752	1522	146	925	1176	1091	73	650	298	14	24	15	13	8	9	9	9	11	0	10	1	3	0	3	8	2	2
K	85.4	86.5	87.2	88.3	88.4	89.4	----	91.5	91.80	12826	1349	3008	1349	683	1986	--	1875	503	32	30	29	29	17	21	—	16	14	34	22	21	10	0	6	—	21	8
L	86.7	87.9	88.0	88.0	88.9	90.7	91.1	98.6	94.90	1091	1792	843	683	1798	1892	24	476	192	13	12	10	12	8	6	6	4	7	0	11	0	0	0	1	1	7	2
M	86.7	87.0	88.2	88.0	88.9	91.5	91.3	91.8	92.70	5165	2378	220	1008	1525	1798	31	3964	1939	28	18	10	9	10	11	8	21	11	45	16	0	0	0	0	5	50	10
N	84.6	84.4	86.6	86.9	87.7	89.8	89.6	89.9	90.50	1262	1005	448	925	1436	1176	11	911	429	27	29	17	22	16	12	16	11	11	5	33	14	20	0	0	3	16	10
O	87.4	87.2	87.5	88.4	----	----	91.1	90.7	91.10	4069	1173	763	683	----	----	05	1023	381	34	18	29	18	—	—	13	12	15	21	20	12	13	—	—	12	14	13
P	88.2	87.9	88.7	88.4	----	----	89.3	90.3	90.50	1349	2178	1176	603	----	——	17	987	**1193**	22	15	16	24	—	--	14	13	16	7	9	2	13	--	--	10	21	37
Q	87.7	89.0	89.4	90.6	89.6	90.6	90.9	90.9	90.40	3287	1005	146	925	1348	683	23	376	147	41	12	17	16	13	12	9	9	10	146	6	9	10	0	0	8	14	5
R	86.4	87.5	89.1	88.9	90.3	92.1	91.4	91.5	91.90	3697	3343	1608	2378	1436	448	83	824	503	39	30	19	18	17	10	12	11	11	10	21	5	10	0	0	14	14	3
S	87.1	87.7	87.8	90.0	90.0	90.7	91.3	91.9	93.60	2899	1522	2479	1176	3118	1615	61	1401	661	34	20	21	16	14	19	13	12	9	12	18	9	3	5	0	8	21	12
T	----	87.5	87.1	90.9	91.2	92.0	92.2	91.7	93.20	1262	2684	3008	1349	371	763	19	911	293	16	35	24	19	10	12	16	12	13	2	22	3	15	0	0	22	19	12
U	83.5	84.4	84.5	86.4	91.7	91.4	92.2	91.5	92.00	1436	2080	1986	1986	1798	2179	41	887	661	9	17	18	14	7	9	12	8	7	0	5	5	5	0	2	15	12	4
V	84.1	84.8	85.0	84.4	90.8	90.7	91.2	91.5	91.30	3230	1349	1436	763	295	603	96	595	263	14	16	20	17	6	6	10	5	7	3	0	0	5	0	0	7	9	2
W	86.8	89.8	87.3	88.5	90.7	90.1	90.4	91.7	90.80	3344	2378	603	2278	925	925	74	864	355	8	13	14	8	8	7	7	7	8	3	9	0	3	0	0	10	11	2
X	84.5	85.4	89.6	88.3	90.9	91.2	90.0	90.2	90.90	2581	1349	146	1349	603	296	07	503	147	24	21	17	17	10	9	12	9	10	14	19	14	17	0	0	20	12	10
Y	87.2	86.6	87.1	90.7	91.5	91.0	90.1	91.9	94.20	5620	4592	925	295	3943	603	52	733	278	19	17	19	17	12	15	10	11	12	22	17	7	16	5	0	12	16	2
Average	85.6	86.4	87.1	87.9	89.9	91.0	90.9	91.6	92.00	3100	2211	1305	1350	1638	1116	61	1053	671	50	27	25	20	15	12	13	11	11	149	47	28	20	20	2	14	17	9

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TABLE IV

WHITE MASSECUITE BOILING AND CENTRIFUGING DATA

Carbohydrate Res.Div. Number	Apparent Purity: High Green	Apparent Purity: White Massecuite	Formula Rating: Steffene	Formula Rating: Non-Steffene	Percent Crystallization	Temperature °C: Grained	Temperature °C: Boiled	Type of Massecuite	Boiling Time Hours	Centrifugal: R.P.M.	Centrifugal: Diameter Inches
3801	80.7	89.6	51.6	----	46.11	70	82.5	Straight	3.0	1200	40
3802	81.5	91.0	57.0	----	51.35	69	82.5	"	1.94	----	40
3803	87.5	93.2	----	82.0	45.6	80	93.0	Topped	2.25	1200	40
3804	77.5	89.5	----	63.8	53.3	55	85.0	"	3.20	1050	40
3805	86.0	92.3	64.5	----	45.0	75	85.0	"	1.25	1180	48
3806	83.5	90.4	72.10	----	41.81	72	86.0	Straight	2.5	1550	48
3807	82.9	92.0	66.8	----	53.21	70	82.5	"	2.25	1050	40
3808	86.19	92.98	----	81.8	49.16	72	90.0	"	2.1	1200	40
3809	86.8	93.0	----	79.6	46.96	70	86.0	"	2.0	1220	40
3810	83.6	90.55	65.9	----	42.37	75	78.0	"	2.0	1250	40
3811	*74.27	86.75	----	74.7	48.50	70	80	Topped	2.75	1000	40
3812	*78.2	89.60	75.7	----	52.29	68	75	Straight	2.75	1200	40
3813	83.8	91.0	75.3	----	44.44	60	85	"	2.00	1250	40
3814	86.9	93.2	76.4	----	48.09	70	85	"	1.60	1150	40
3815	----	92.4	77.7	----	----	66	83	"	2.17	1190	40
3816	*74.84	87.45	----	59.4	50.11	65	77	Topped	2.66	1140	40
3817	83.40	91.30	77.9	----	47.59	70	88	"	2.80	1130	40
3818	87.00	92.70	71.0	----	43.84	70	83	Straight	1.65	1200	40
3819	85.9	91.70	----	82.4	41.13	82	80	"	2.5	1180	42
3820	86.9	94.20	78.3	----	55.72	79	85	"	2.16	1150	40
3821	82.6	91.30	----	81.2	50.00	70	80	Topped	2.50	1160	40
3822	81.5	90.70	----	74.9	49.72	62	86	"	1.50	1200	40
3823	82.1	90.50	----	76.2	46.92	60	82	"	1.75	1180	40
3824	85.5	92.80	----	69.0	50.34	84	89	Straight	3.25	1400	40
3825	84.1	92.10	54.3	----	50.32	73	85	"	2.50	1200	40
3826	*77.7	89.6	----	70.3	53.36	67	80	Straight	3.0	1500	40
3827	83.54	90.39	----	71.3	41.61	78	78	---	---	1000	40
3828	86.9	92.90	----	76.5	45.80	70	85	Straight	1.5	1200	40
3829	84.4	91.10	----	70.5	42.94	70	84	Topped	2.00	1200	40
3830	83.8	91.0	----	76.8	44.44	78	82	Straight	2.16	1400	40
3831	83.4	91.0	----	65.9	45.78	74	84	Straight	2.00	1225	40
3832	83.2	91.3	81.3	----	48.21	—	—	Topped	1.66	1100	40
3833	87.5	93.6	75.7	----	48.80	68	80	Straight	1.75	1188	40
3834	82.1	90.4	84.3	----	46.36	65	79	Topped	1.96	1220	40
3835	82.6	91.0	----	84.2	48.27	71	85	Straight	1.75	1100	40
3836	86.4	92.0	----	72.4	41.17	68	82	Straight	1.53	1100	40
3837	86.8	93.2	----	80.9	48.48	70	85	"	2.00	1200	42
3838	89.5	94.9	86.1	----	51.42	73	90	"	2.00	1500	40
3839	84.8	92.4	80.4	----	50.00	65	80	"	1.75	1200	48
3840	84.7	91.9	80.4	----	47.05	75	89	"	1.87	1400	40
3841	87.4	93.1	69.6	---	45.23	82	85	Straight	1.33	1200	40
3842	85.5	91.7	83.4	---	42.75	70	83	"	2.25	1200	40
3843	85.1	92.6	62.7	---	50.33	72	82	"	1.80	1250	40
3844	85.5	92.5	67.8	---	48.27	79	84	"	1.9	1200	40
3845	84.8	92.1	----	83.0	48.02	70	86	"	1.63	1500	42
3846	81.7	90.9	----	84.3	50.27	70	85	Straight	1.83	1200	40
3847	87.2	92.7	65.6	---	42.96	73	85	"	2.00	1170	40
3848	85.6	91.9	75.4	---	43.75	65	75	"	2.33	1225	40
3849	85.5	92.2	----	77.8	46.20	77	83	"	1.92	1100	40
3850	85.6	91.5	65.6	---	40.97	60	85	"	2.00	1200	40
3851	86.3	91.8	---	85.1	40.14	70	80	Straight	1.38	1250	40
3852	88.6	94.2	---	64.6	49.12	87	86	"	1.66	1400	40
3853	81.4	90.8	----	78.2	50.53	60	80	"	2.43	1200	40
3854	85.5	92.1	---	73.8	45.51	70	79	"	2.43	1200	40
3855	85.5	91.8	68.7	---	43.44	62	81	"	2.36	1300	40
3856	86.0	92.4	29.7	----	45.71	72	86	Straight	1.75	1600	40
3857	85.7	92.0	---	75.4	44.05	68	78	"	1.76	1200	48
3858	81.9	88.4	37.8	----	35.91	72	84	"	1.92	1200	40
3859	85.1	91.3	---	52.4	41.61	76	82	"	1.66	1400	40
3860	82.0	90.1	78.0	----	45.00	57	80	---	2.00	1250	40
3861	84.2	90.5	---	55.7	39.87	72	82	Straight	1.5	1200	40
3862	86.8	92.9	---	75.1	46.21	—	—	"	1.42	----	40
3863	86.6	92.2	28.2	---	38.88	70	84	"	1.75	1200	40
3864	83.4	90.6	26.2	---	43.37	65	79	"	2.00	1150	40
3865	81.1	90.3	---	82.6	48.67	62	68	"	2.00	1200	40
3866	86.0	92.4	---	49.3	45.71	78	85	Straight	1.25	1140	40
3867	83.0	90.8	74.4	---	45.88	68	90	"	2.00	1200	40
3868	84.2	91.7	---	79.7	47.46	68	90	"	2.00	1200	40
3869	85.7	92.7	47.9	---	48.95	77	90	"	1.83	1220	40
3870	86.4	92.3	66.2	----	43.38	60	79	"	1.83	1250	40
3871	84.6	91.5	---	60.6	44.80	72	82	Straight	3.00	1200	40
3872	80.9	90.6	53.8	---	50.78	65	85	"	2.10	1400	40
3873	87.2	93.5	---	84.1	49.21	72	88	"	1.83	1400	40
3874	84.9	91.6	----	82.6	44.37	60	82	"	2.50	1200	40
3875	84.4	91.8	---	67.6	47.43	78	85	"	2.00	1200	40
3876	89.1	93.6	70.2	---	41.28	80	80	Straight	1.93	1100	36
Average	84.69	91.80	66.41	73.84	46.44	70.4	83.2	----	2.04	----	---

*2-boiling or especial syeteme not included in average.

Joey	0.0	0.2	12.4	46.0	7.4	11.4	6.0	8.0	8.6
3830	0.2	4.4	33.0	33.8	10.6	7.8	4.2		

TABLE V.

SCREENING TESTS -- COMPARISON OF GRAIN SIZE

Meshes to the inch	20	28	35	48	60	65	80	100	100
U. S. Series Equiv. No.	20	30	40	50	60	70	80	100	100

Carbohydrate Ree. Div. No.	Percent retained on	Percent retained on	Percent retained on	Percent retained on	Percent retained on	Percent retained on	Percent retained on	Percent retained on	Percent passed through
3801	0.2	3.6	38.6	45.6	5.8	2.6	1.2	1.2	1.2
3802	0.0	0.5	17.3	45.0	9.2	11.0	7.0	6.0	4.0
3803	0.0	0.2	26.2	46.6	9.0	8.0	5.0	3.0	2.0
3804	0.0	1.0	49.6	36.4	6.4	3.6	1.8	0.6	0.6
3805	0.0	0.4	17.2	47.2	11.6	9.2	5.8	5.6	3.0
3806	0.0	0.6	19.6	42.0	12.0	10.2	5.8	6.4	3.4
3807	0.0	0.0	57.8	26.0	6.4	4.2	2.6	2.0	1.0
3808	0.0	1.6	41.4	33.6	7.6	6.4	4.6	3.4	1.4
3809	0.0	1.0	34.6	19.6	28.4	6.8	4.4	3.4	1.8
3810	0.2	1.4	45.2	33.0	6.4	4.6	3.6	3.6	2.0
3811	0.2	0.8	42.6	36.4	6.8	4.8	3.6	2.4	2.4
3812	0.2	4.8	42.4	30.4	9.0	6.2	3.4	2.6	1.0
3813	0.2	0.6	33.6	40.8	7.0	8.8	3.4	3.4	2.2
3814	0.2	1.6	45.2	32.6	7.6	5.2	3.0	2.6	2.0
3815	0.0	0.4	17.6	52.6	8.8	10.0	4.6	4.4	1.6
3816	0.2	0.6	42.2	36.4	7.6	5.8	2.8	2.8	1.6
3817	0.2	4.4	45.6	30.4	6.4	4.6	3.0	2.8	2.6
3818	0.0	0.6	26.4	43.4	11.6	7.4	4.4	3.8	2.4
3819	0.2	4.8	36.4	32.6	9.2	7.4	3.8	3.4	2.2
3820	0.2	0.6	18.2	39.4	12.0	10.6	6.4	6.4	6.2
3821	0.0	1.0	36.0	39.4	8.2	6.4	4.4	2.8	1.8
3822	0.0	0.6	26.2	42.6	9.6	8.0	4.6	4.4	4.0
3823	0.2	1.8	23.6	41.4	9.4	8.6	5.6	5.4	4.0
3824	0.2	4.6	37.4	35.8	7.2	6.2	3.4	3.0	2.2
3825	0.0	2.0	36.0	31.8	8.4	12.2	5.4	2.2	2.0
3826	0.0	2.2	43.6	31.8	7.4	6.4	3.4	3.2	2.0
3827	0.0	3.0	42.6	32.6	7.4	6.2	4.0	2.6	1.6
3828	0.0	0.8	25.6	43.6	8.0	9.4	5.0	4.6	3.0
3829	0.0	0.2	12.4	46.0	7.4	11.4	6.0	8.0	8.6
3830	0.2	4.4	33.0	33.8	10.6	7.8	4.2	4.0	2.0
3832	0.2	0.4	29.2	44.2	9.0	7.6	3.8	3.4	2.2
3833	0.0	0.2	26.6	40.0	10.6	8.8	5.4	4.4	4.0
3834	0.2	0.4	28.8	49.0	9.4	5.6	2.8	2.2	1.6
3835	0.0	0.4	36.2	38.4	8.6	7.0	4.0	3.4	2.0
3836	0.0	0.4	25.0	31.4	19.2	8.8	5.4	5.2	4.6
3837	0.0	0.6	23.6	38.4	10.8	10.2	6.4	5.4	4.6
3838	0.0	0.4	26.4	39.0	11.8	7.0	5.2	5.2	5.0
3839	0.0	0.4	38.4	38.8	7.8	6.4	3.4	3.2	1.6
3840	0.0	0.6	26.8	43.2	10.0	6.8	4.6	4.2	3.8
3841	0.0	0.2	23.8	48.0	10.2	7.4	4.4	4.2	1.8
3842	0.0	0.2	17.6	37.0	11.2	10.0	7.0	8.0	9.0
3843	0.0	0.8	39.4	32.4	9.4	7.0	4.4	3.6	3.0
3844	0.2	1.4	27.8	39.2	11.0	8.0	4.8	4.6	3.0
3845	0.0	0.2	31.6	40.2	9.4	7.0	5.0	4.2	2.4
3846	0.2	1.2	47.8	36.4	6.2	4.0	2.0	1.2	1.0
3847	0.0	0.4	15.4	40.0	11.6	10.6	6.6	7.8	7.6
3848	0.0	0.2	21.8	52.6	9.2	7.6	3.6	3.4	1.6
3849	0.0	0.2	17.2	44.2	11.8	11.6	5.4	6.0	3.6
3850	0.0	0.0	6.2	47.8	12.4	12.4	6.2	7.4	7.6
3851	0.0	1.4	31.8	31.2	10.0	9.6	2.8	9.0	4.2
3852	0.0	0.2	26.0	42.2	9.8	8.4	4.6	4.2	2.6
3853	0.0	0.6	35.8	38.6	8.6	6.4	3.4	3.8	2.8
3854	0.0	0.4	26.4	39.2	7.0	10.6	6.0	6.4	4.0
3855	0.0	0.2	16.6	38.4	11.6	10.6	6.8	8.2	7.6
3856	0.0	0.2	4.2	44.2	17.8	12.6	7.4	7.4	6.2
3857	0.0	0.8	21.4	40.6	10.0	11.0	6.0	6.0	4.2
3858	0.0	0.6	16.8	40.6	12.2	10.6	6.8	7.0	5.4
3859	0.0	0.4	9.6	48.4	12.0	12.6	5.8	7.0	4.2
3860	0.2	0.4	15.6	49.4	12.8	8.6	5.0	5.2	2.8
3861	0.0	0.4	32.6	41.0	9.4	7.0	4.6	3.4	1.6
3862	0.2	2.8	30.0	35.6	10.8	9.4	4.6	4.6	2.0
3863	0.0	0.2	11.0	44.8	14.2	10.8	7.2	6.8	5.0
3864	0.0	0.8	23.6	38.0	10.0	9.6	6.8	8.8	2.4
3865	0.0	0.2	21.0	42.0	8.8	9.4	5.6	6.8	6.2
3866	0.0	0.2	26.0	47.8	7.6	7.8	4.2	3.8	2.6
3867	0.0	0.0	17.0	53.4	9.4	8.2	4.4	4.6	3.0
3868	0.0	0.2	34.4	41.4	7.8	7.6	4.2	3.2	1.2
3869	0.0	0.2	16.8	39.6	12.8	12.0	6.0	6.8	5.8
3870	0.0	0.2	32.0	43.6	8.2	6.6	3.8	3.4	2.2
3871	0.0	0.4	11.8	39.8	10.8	13.4	6.2	9.0	8.6
3872	0.0	0.2	20.0	57.2	9.4	5.8	3.4	2.8	1.2
3873	0.0	0.2	16.2	52.0	10.2	9.2	4.8	4.4	3.0
3874	0.0	0.2	26.8	32.6	8.0	9.8	6.2	8.2	8.2
3875	0.0	0.2	15.0	52.0	7.0	11.0	4.2	5.8	4.8
3876	0.0	0.4	17.8	48.6	10.2	9.4	5.4	5.4	2.8
3877	*0.2	1.4	19.0	45.0	12.2	8.2	5.6	4.4	4.0
Average	.05	.93	27.61	40.54	9.85	8.3	4.71	4.66	3.34

* Special sugar not included in the average.

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TABLE VI

COMPARISON OF REFLECTANCES OF BEET SARS FROM THE SAME FACTORIES

Carbohydrate Res.Div. Number	1938	1937	1936	1935	1934
3801	90.20	----	90.47	88.82	86.83
3802	89.40	91.31	90.21	88.57	89.91
3803	91.40	92.41	89.52	----	----
3804	90.50	90.31	88.67	88.72	89.82
3805	91.40	91.80	91.23	89.55	89.30
3806	91.5	90.35	90.03	----	----
3807	90.3	90.41	90.66	88.52	91.80
3808	90.8	92.21	90.58	90.37	90.08
3809	91.4	91.46	90.52	90.38	----
3810	89.8	92.65	91.32	90.32	89.82
3811	90.8	91.73	91.43	89.60	90.34
3812	90.7	90.51	89.80	90.55	90.60
3813	91.8	91.98	92.35	91.85	91.11
3814	90.6	92.61	91.48	90.00	89.39
3815	92.0	93.20	90.51	91.28	91.29
3816	90.2	90.25	90.38	90.72	89.39
3817	91.0	92.41	89.61	90.53	90.25
3818	91.2	92.95	91.43	91.17	90.17
3819	91.3	90.90	----	----	----
3820	94.3	93.71	92.45	92.47	92.15
3821	89.70	90.76	90.83	88.87	90.34
3822	91.90	92.91	----	----	----
3823	91.40	92.01	90.55	90.57	90.51
3824	90.80	90.91	----	----	----
3825	88.60	90.35	89.87	89.23	89.04
3826	89.50	91.31	89.17	88.30	88.87
3827	90.40	91.63	91.22	----	----
3828	92.40	----	----	----	----
3829	93.40	93.08	89.42	----	----
3830	90.80	92.41	91.27	89.85	89.91

Carbohydrate Res.Div. Number	19	1937	1936	1935	1934
3831	90	90.50	86.78	89.73	89.30
3832	91	93.03	92.28	93.57	91.72
3833	91	93.60	91.25	91.47	91.46
3834	92	93.76	93.27	92.58	91.37
3835	91	92.28	92.20	90.68	90.08
3836	91	92.26	89.43	89.32	88.36
3837	93	92.48	91.83	91.90	91.11
3838	92	93.10	90.66	89.93	87.92
3839	91	91.36	----	----	----
3840	92	92.81	92.40	91.27	90.85
3841	92	92.63	91.67	91.68	91.20
3842	94	93.66	93.07	91.68	89.82
3843	89	90.25	90.63	90.75	89.39
3844	90	91.98	91.92	90.38	90.17
3845	92	93.11	----	----	----
3846	91	92.91	92.08	91.25	91.63
3847	92	93.26	92.50	----	----
3848	91	92.68	91.53	90.53	89.39
3849	91	----	----	----	----
3850	94	93.73	91.42	----	----
3851	92	92.73	92.23	91.62	92.23
3852	94	93.38	91.57	91.12	91.37
3853	91	91.46	90.94	90.96	90.85
3854	93	92.60	90.85	89.25	90.60
3855	91	93.46	----	----	----
3856	93	----	----	----	----
3857	92	92.81	92.42	90.80	91.72
3858	91	91.85	90.83	89.60	90.00
3859	92	94.05	91.55	----	----
3360	93	92.90	92.65	91.18	91.37

Carbohydrate Res.Div. Number	1938	1937	1936	1935	1934
3861	91.7	93.65	92.31	----	----
3862	91.5	90.75	90.22	88.93	88.99
3863	94.3	94.25	93.75	91.25	89.22
3864	90.7	91.86	88.55	92.02	91.11
3865	92.5	93.05	92.05	91.29	91.28
3866	93.3	93.26	92.52	92.40	----
3867	91.3	92.43	90.64	89.28	90.68
3868	92.2	----	----	----	----
3869	91.5	91.71	89.53	90.02	89.22
3870	92.3	----	----	----	----
3871	91.90	92.26	90.93	89.85	----
3872	90.60	92.16	91.93	90.42	91.20
3873	92.90	92.70	----	----	----
3874	91.80	----	----	----	----
3875	93.00	92.81	89.78	----	----
3876	92.9	93.11	91.25	91.70	90.42
3877*	93.8	93.93	93.52	93.13	90.60
Averagee	91.72	92.27	91.05	90.44	90.27

*Special sugar not included in averages

TABLE VII

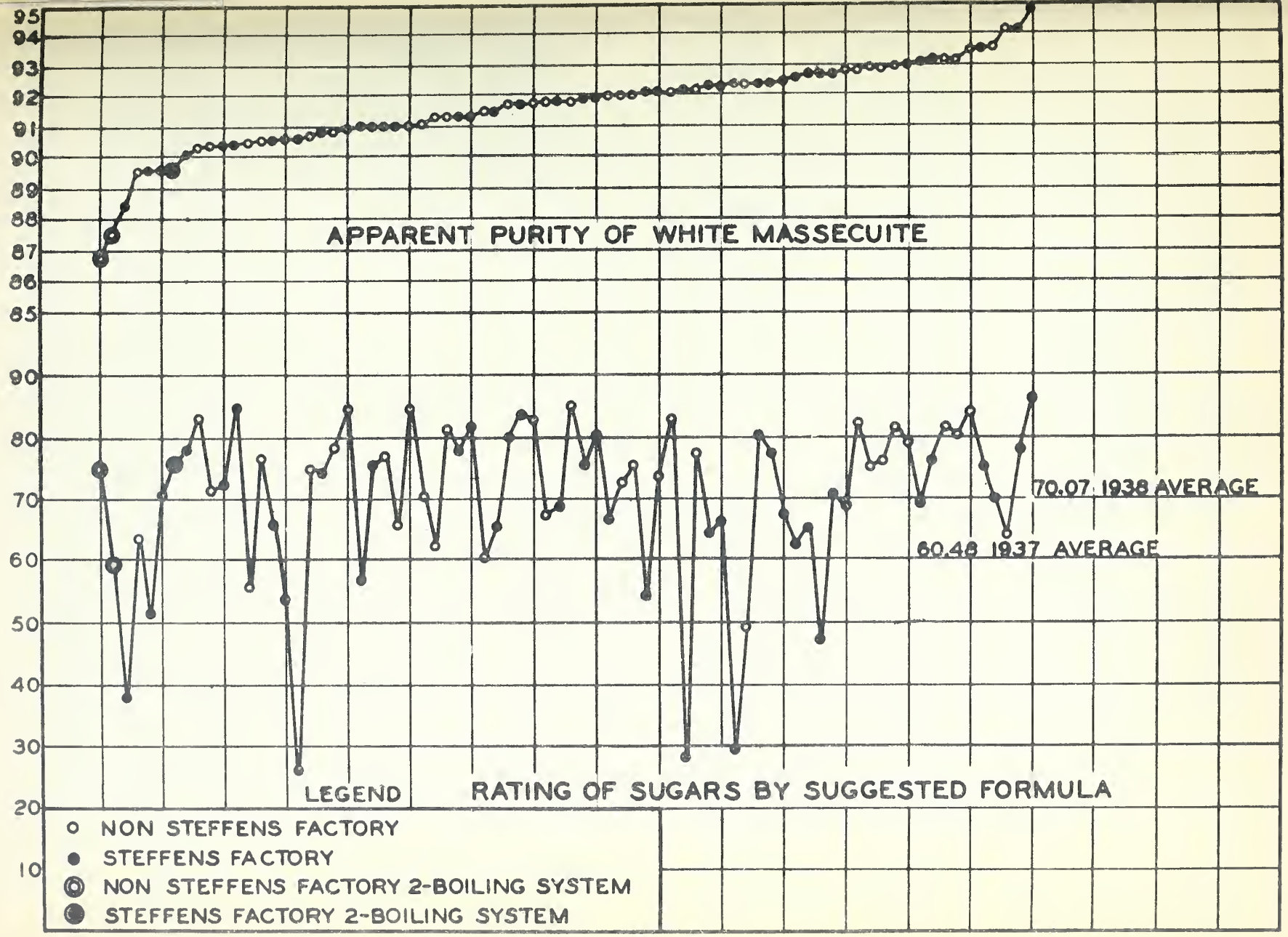
Carbohydrate Div. No.	B-K Turbidity Index	B-K Color Index	Ash, % x 10³	Formula Rating	Apparent Purity of White Massecuite
3801	17.1	13.3	18.0	51.6	89.6
3802	18.6	12.4	12.0	57.0	91.0
3803	5.2	5.8	7.0	82.0	93.2
3804	19.6	5.6	11.0	63.8	89.5
3805	12.7	12.8	10.0	64.5	92.3
3806	9.5	7.4	12.0	72.1	90.4
3807	15.2	11.0	7.0	66.8	92.0
3808	4.6	7.8	5.8	81.8	92.98
3809	9.0	4.4	7.0	79.6	93.00
3810	14.4	10.7	9.0	65.9	90.55
3811	6.7	6.6	12.0	74.7	86.75
3812	6.1	6.7	11.5	75.7	89.60
3813	9.0	3.7	12.0	75.3	91.00
3814	5.3	9.3	9.0	76.4	93.20
3815	5.6	6.2	10.5	77.7	92.40
3816	20.5	7.6	12.5	59.4	87.45
3817	6.3	7.3	8.5	77.9	91.30
3818	11.0	6.0	12.0	71.0	92.70
3819	5.5	4.6	7.5	82.4	91.70
3820	5.2	5.5	11.0	78.3	94.20
3821	6.0	7.8	5.0	81.2	91.30
3822	13.3	3.3	8.5	74.9	90.70
3823	8.0	5.3	10.5	76.2	90.50
3824	10.8	8.2	12.0	69.0	92.80
3825	20.5	16.2	9.0	54.3	92.10
3826	15.4	5.8	8.5	70.3	89.60
3827	14.5	6.2	8.0	71.3	90.39
3828	6.9	6.6	10.0	76.5	92.90
3829	7.1	7.4	15.0	70.5	91.10
3830	6.0	5.2	12.0	76.8	91.00
3831	15.3	6.3	12.5	65.9	91.00
3832	5.0	6.7	7.0	81.3	91.30
3833	7.4	4.4	12.5	75.7	93.60
3834	2.8	2.9	10.0	84.3	90.40
3835	3.5	5.3	7.0	84.2	91.00
3836	9.7	5.9	12.0	72.4	92.00
3837	5.5	1.1	12.5	80.9	93.20
3838	3.7	3.2	7.0	86.1	94.90
3839	3.9	7.7	8.0	89.0	92.45
3840	2.8	4.2	12.6	80.4	91.90
3841	8.7	5.7	16.0	69.6	93.10
3842	3.5	3.1	10.0	83.4	91.70
3843	18.3	9.5	9.5	62.7	92.60
3844	10.9	11.8	9.5	67.8	92.50
3845	2.7	2.8	11.5	83.0	92.10
3846	2.8	3.4	9.5	84.3	90.90
3847	13.0	10.4	11.0	65.6	92.70
3848	9.2	4.9	10.5	75.4	91.90
3849	5.6	6.6	10.0	77.8	92.20
3850	13.8	8.6	12.0	65.6	91.50
3851	3.3	2.1	9.5	85.1	91.80
3852	16.9	7.0	11.5	64.6	94.20
3853	6.4	4.4	11.0	78.2	90.80
3854	6.6	8.1	11.5	73.8	92.10
3855	9.3	8.0	14.0	68.7	91.80
3856	38.7	20.1	11.5	29.7	92.40
3857	12.0	5.6	7.0	75.4	92.00
3858	17.0	12.2	33.0	37.8	88.40
3859	19.6	8.0	20.0	52.4	91.30
3860	6.0	5.0	11.0	78.0	90.10
3861	20.5	7.8	16.0	55.7	90.50
3862	10.1	6.3	8.5	75.1	92.90
3863	37.8	22.0	12.0	28.2	92.20
3864	48.0	11.8	14.0	26.2	90.60
3865	3.6	4.1	9.5	82.8	90.30
3866	20.3	10.4	20.0	49.3	92.40
3867	6.6	11.0	8.0	74.4	90.80
3868	7.5	7.3	5.5	79.7	91.70
3869	30.9	10.4	10.8	47.9	92.70
3870	7.5	7.3	19.0	66.2	92.30
3871	16.7	10.2	12.5	60.6	91.50
3872	21.2	11.7	13.3	53.8	90.60
3873	4.9	5.0	6.0	84.1	93.50
3874	3.9	5.0	8.5	82.6	92.80
3875	13.5	9.9	9.0	67.6	91.80
3876	12.9	8.2	8.7	70.2	93.60
3877*	4.7	4.2	11.5	79.6	93.75
Average	11.43	7.50	10.99	70.07	91.80
1937	19.76	8.16	11.60	60.48	-----

*Special Sugar Not Included in Averages

TABLE III

Comparison of % Molasses Worked i Steffens Factories 1937-1938

Carbo-hydrate Research Division Number	Purity White Massecuite 1938	Purity White Massecuite 1937	Molasses Worked % on Beets 1938	Molasses Worked % on Beets 1937	Increased Amou 1938 over 1937	Increased Amou 19 ov 19	Sugar Rating by Formula 1938	Sugar Rating by Formula 1937	Formula Rating Increase and per cent molasses worked: Rating Increase 1938-1937	% Molasses Decrease 1938-1937	Rating Increase 1938-1937	% Molasses Increase 1938-1937
3858	88.40	88.20	8.14	8.29	----	5	37.8	47.3	---	---	--- 9.5	--- .15
3812	89.60	89.29	4.65	4.19	.46	-	75.7	63.0	---	---	--- --- 12.7	--- .46 ---
3860	90.10	89.50	6.61	6.77	----	6	78.0	73.8	4.2	---	.16 ---	--- --- --- ---
3806	90.40	86.90	7.67	10.55	----	28	72.1	42.8	29.3	---	2.88 ---	--- --- --- ---
3834	90.40	90.90	4.74	4.26	.48	-	84.3	79.5	---	---	--- ---	4.8 --- .48 ---
3810	90.55	90.40	5.28	4.38	.90	-	65.9	58.1	---	---	--- ---	7.8 --- .90 ---
3872	90.60	90.70	6.43	6.55	----	2	53.8	45.3	8.5	---	.12 ---	--- --- --- ---
3864	90.60	90.60	6.06	5.78	.28	-	26.2	44.8	---	18.6	--- .28	--- --- --- ---
3867	90.80	91.70	9.04	10.98	----	14	74.4	70.1	4.3	---	1.94 ---	--- --- --- ---
3802	91.00	91.50	6.89	6.28	.61	-	57.0	59.9	---	2.9	--- .61	--- --- --- ---
3813	91.00	90.80	5.71	5.68	.03	-	75.3	63.5	---	---	--- ---	11.8 --- .03 ---
3817	91.30	91.30	5.94	5.33	.61	-	77.9	66.7	---	---	--- ---	11.2 --- .61 ---
3832	91.30	91.50	8.53	7.61	.92	-	81.3	77.8	---	---	--- ---	3.5 --- .92 ---
3850	91.50	91.50	5.87	6.11	----	4	65.6	65.9	---	---	--- ---	--- .3 --- .24
3842	91.70	91.00	5.59	6.16	----	7	83.4	60.9	22.5	---	.57 ---	--- --- --- ---
3855	91.80	91.5	6.95	6.19	.76	-	68.7	47.9	---	---	--- ---	20.8 --- .76 ---
3848	91.90	91.6	5.57	6.12	----	5	75.4	66.9	8.5	---	.55 ---	--- --- --- ---
3840	91.90	91.4	6.64	6.47	.17	-	80.4	66.8	---	---	--- ---	13.6 --- .17 ---
3807	92.00	92.50	5.02	5.39	----	7	66.8	57.4	9.4	---	.37 ---	--- --- --- ---
3825	92.10	91.00	6.49	4.94	1.55	-	54.3	48.1	---	---	--- ---	6.2 --- 1.55 ---
3863	92.20	91.00	6.63	6.32	.31	-	28.2	24.8	---	---	--- ---	3.4 --- .31 ---
3805	92.30	92.80	9.02	9.52	---	)	54.5	57.0	---	---	--- ---	2.5 --- .50 ---
3839	92.40	93.20	7.07	7.58	---	1	80.4	62.7	17.7	---	.51 ---	--- --- --- ---
3815	92.40	91.90	12.22	7.19	5.03	-	77.7	73.0	---	---	--- ---	4.7 --- 5.03 ---
3844	92.50	92.00	6.11	6.35	----	1	67.8	62.4	5.4	---	.24 ---	--- --- --- ---
3843	92.60	92.50	5.78	5.75	.03	-	62.7	49.2	---	---	--- ---	13.5 --- .03 ---
3847	92.70	92.40	7.06	6.87	.19	-	65.6	48.1	---	---	--- ---	17.5 --- .19 ---
3869	92.70	91.80	5.85	7.44	---	1	47.9	4.8	43.1	---	1.59 ---	--- --- --- ---
3818	92.70	92.10	6.91	6.46	.45	-	71.0	71.4	---	---	--- ---	--- .4 --- .45
3841	93.10	92.20	6.63	7.53	---	)	69.6	62.1	7.5	---	.90 ---	--- --- --- ---
3814	93.20	92.30	7.93	9.72	---	1	76.4	66.8	9.6	---	1.79 ---	--- --- --- ---
3833	93.60	93.10	7.59	7.12	.47	-	75.7	73.3	---	---	--- ---	2.4 --- .47 ---
3876	93.60	91.90	6.49	6.67	---	3	70.2	39.9	40.3	---	.18 ---	--- --- --- ---
3820	94.20	91.90	6.43	6.89	---	3	78.3	68.1	10.2	---	.46 ---	--- --- --- ---
3838	94.90	98.6	6.54	7.64	---	1	86.1	81.8	4.3	---	1.10 ---	--- --- --- ---
Totals	-----	-----	---	---	13.25	14	---	---	224.8	21.5	13.36 .89	136.4 10.2 12.41 .84
Average	-----	-----	6.74	6.75	.779	01	---	---	-----	---	---- ----	---- ---- ---- ---


APPARENT PURITY OF WHITE MASSECUITE
95
94
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70.07 1938 AVERAGE
60.46 1937 AVERAGE
LEGEND
RATING OF SUGARS BY SUGGESTED FORMULA
NON STEFFENS FACTORY
STEFFENS FACTORY
NON STEFFENS FACTORY 2-BOILING SYSTEM
STEFFENS FACTORY 2-BOILING SYSTEM

FIGURE I

II. Report on Biological Studies of Sugars.

by
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This part of the report concerns the factors which influence the biological quality of sugar. Examination was made of the samples for substances which stimulate the growth of yeasts in sugar solutions and which therefore determine the suitability of the sugar for use in the manufacture of beverages. The samples were likewise examined for the thermophilic bacteria which cause spoilage in non-acid canned foods.

The data presented in this part of the report were obtained by the examination of samples represented in the preceding part and the same Carbohydrate Division numbers are used to identify the samples. The results obtained are presented in two parts, as follows: (1) The results of the examination for yeast stimulating substances, and (2) the results of the examination for thermophilic bacteria.

Part I. Examination for Yeast-Stimulating Substances.

The significance of yeast-stimulating substances has received con-considerable attention by numerous investigators during recent years. Comprehensive reviews of the entire subject under the heading of "Bios" were published in scientific journals, as follows: "The Bios Question" by F. W. Tanner, published in Chemical Reviews, volume 1, 397-472 (1924) and "Review of Bios" by W. L. Miller, published in the Journal of Chemical Education, volume 7, 257-267 (1930). Numerous other papers have been published regarding "bios" in several scientific journals since the later review was written. The significance of these substances in white sugar was discussed in a previous report (Report on Biological Studies of Sugar, 1932) and in an article entitled "Yeast Growth Stimulants in White Sugars" by Hall, James and Stuart, published in Ind. Eng. Chem., volume 25, 1052 (1933), and in which a practical laboratory method for the determination of yeast stimulants in sugar was given. The location of stimulating substances with respect to the surface of sugar crystals was determined and reported in an article "Crystal Surface Contaminants and Biological Quality of Sugar" by Hall and James, published in Facts About Sugar, June, 1936. Briefly, it was found that these substances are located at or near the crystal surface and that elimination is facilitated by the complete removal of mother liquors from the white sugar.

Various samples of sugar, taken from different factories and representing different variations in methods of purification, were studied.

In testing these sugar samples, the amounts of yeast growth obtained in 10 percent solutions of the sugars were used as a basis for classifying the sugars on what might be termed their "biological quality".

During the past campaign the same procedure was followed as described in the report issued in 1932 and in the article by Hall, James and Stuart. Seventy-seven samples of white sugar, collected by the Carbohydrate Research Division, were thus classified.

The number of yeast cells placed in each test sugar solution (i.e. the "inoculum") is rated as one unit, and the number of cells developing on incubation in any one sample is considered a multiple of the number of cells in the inoculum. This total yeast growth is termed the yeast crop. The samples are ranked in ascending order of their yeast inoculum multiples and are identified by their Carbohydrate Research Division numbers. The results are given in Table I, p. 8.

The results of this examination show a slight improvement in the biological quality of the samples as compared with those from the 1937 campaign. Only one sample, No. 3872, had a higher yeast inoculum multiple than the highest obtained last year. The average multiples for all samples obtained during the past four campaigns are given as follows:

Year	Yeast Inoculum Multiple
1938	7.6
1937	8.0
1936	8.6
1935	12.4

During the past few years there has been a correlation between the amount of yeast stimulating substance and the ash content of the sugar. This relationship was found to exist again this year but to a lesser extent. Whereas, last year the average ash content of the sugars with a multiple below 10.0 was 0.0105 percent, and that of sugars with a multiple of 10.0 and over was 0.0151 percent; this year it was 0.0106 and 0.0116 percent, respectively.

Part II. Bacteriological Examination.

The usual bacteriological examination was made of the samples to determine their suitability for canning purposes. The methods prescribed by the National Canners Association for the examination of sugar for thermophilic bacteria, including "total aerobic" count, "flat sour" types, "hard swell" types and "hydrogen sulfide" types, were used. References to various publications regarding the presence and significance of these types of microorganisms occurring in sugar have been given in previous reports. A sig-

TABLE I

Ranking of Sugar Samples Collected During 1938 Campaign.

Carbohydrate Division Number	Rank	Yeast Inoculum Multiple	Carbohydrate Division Number	Rank	Yeast Inoculum Multiple
3841	1	1.4	3825	40	6.6
3802	2	2.4	3871	41	6.6
3812	3	2.6	3810	42	6.8
3813	4	2.6	3818	43	7.2
3854	5	2.8	3833	44	7.2
3864	6	3.2	3839	45	7.2
3803	7	3.4	3811	46	7.4
3830	8	3.4	3845	47	7.4
3869	9	3.4	3804	48	7.6
3805	10	4.0	3820	49	7.6
3877	11	4.0	3821	50	7.6
3846	12	4.2	3807	51	7.8
3829	13	4.4	3809	52	8.0
3823	14	4.6	3862	53	8.2
3857	15	4.6	3836	54	8.4
3858	16	4.6	3865	55	8.8
3835	17	4.8	3808	56	9.2
3851	18	4.8	3834	57	10.0
3874	19	5.0	3848	58	10.0
3831	20	5.2	3859	59	10.0
3855	21	5.2	3837	60	10.2
3863	22	5.2	3856	61	10.2
3867	23	5.2	3828	62	10.6
3826	24	5.4	3847	63	10.6
3844	25	5.4	3868	64	11.0
3850	26	5.4	3860	65	11.4
3870	27	5.4	3866	66	12.8
3876	28	5.4	3853	67	13.0
3838	29	5.6	3873	68	13.6
3852	30	5.6	3816	69	14.0
3843	31	5.8	3842	70	14.2
3861	32	5.8	3875	71	14.2
3824	33	6.2	3819	72	15.0
3815	34	6.4	3806	73	16.2
3827	35	6.4	3849	74	17.2
3832	36	6.4	3801	75	18.2
3814	37	6.6	3840	76	18.2
3817	38	6.6	3872	77	25.2
3822	39	6.6			

nificant change has been made in the composition of the medium to be used for the detection of "hydrogen sulfide" type spores. The medium is now simplified and is more easily prepared than that formerly used for this test. The composition of the medium is given by Cameron of the National Canners Association laboratories, in a "Report on Methods For Detecting and Estimating Numbers of Thermophilic Bacteria in Sugar" published in the Journal of the Association of Official Agricultural Chemists, August, 1938. This medium supercedes that given in the report by Cameron, "Report on Culture Media For Non-Acid Products" published in the Journal of the Association of Official Agricultural Chemists, August, 1936. Details of the methods used are contained in a report by the same author, "Report on Methods For Detecting and Estimating Numbers of Thermophilic Bacteria in Sugar", published in the Journal of the Association of Official Agricultural Chemists, August, 1936.

It is again brought to your attention that in order to be acceptable for use in canning, sugars must conform to certain bacteriological standards, which limit the number of spores of the types of bacteria permitted. The maximum numbers of bacterial spores permitted by the National Canners Association, based on the examination of five samples from a single lot of sugar, are as follows:

Total Aerobic Thermophilic Spores:

"For the five samples examined, there shall be a maximum of not more than 150 spores and an average of not more than 125 spores per 10 grams of sugar."

Aerobic Flat Sour Spores:

"For the five samples examined, there shall be a maximum of not more than 75 spores and an average of not more than 50 spores per 10 grams of sugar."

Anaerobic Sulfide Spoilage Spores:

"These shall be present in not more than two (40 percent) of the five samples and in any one sample to the extent of not more than five spores per 10 grams."

Anaerobic Thermophilic Hard Swell Spores:

"These shall be present in not more than three (60 percent) of the five samples and in any one sample to the extent of not more than four (65+ percent) tubes (method for testing)."

The suitability of the campaign composite samples of sugar for canning purposes is based on the minimum numbers of spores of any type permitted for five samples as shown by the above standards. For the purpose of this report the results from the campaign composite sample shall be considered equivalent to the averaged results obtained from five individual samples.

For the benefit of control laboratories wishing to compare bacteriological results with those given in this part of the report the media used for the tests is given as follows: (a) total aerobic thermophilic spores and aerobic flat sour spores determined with Difco dextrose-tryptone agar, Reference No. 309, 478, (b) anaerobic sulfide spoilage spores determined with Cameron's simplified medium, and, (c) anaerobic thermophilic hard swell type spores determined with liver broth as described in the above "Report On Culture Media For Non-Acid Products."

The results obtained on the samples examined are shown in Table II, pages 11 and 12.

Three samples, or 3.9 percent, contained spores in excess of the numbers permitted by the National Canners Association standards for canning grade sugars. These samples, Nos. 3816, 3835, and 3867, contained excessive total aerobic and flat sour type spores.

A slight improvement is shown again this year in the bacteriological quality of the samples. There has been a continued improvement in the samples during each of the past four years as shown in the following tabular data.

Year	No. samples tested	No. samples passed	Percent samples passed
1938	77	74	96.1
1937	70	65	92.9
1936	70	59	83.6
1935	65	47	72.4

Continued improvement in the bacteriological quality of a few samples is still to be desired. The production of sugar barely meeting the National Canners Association canning grade standards is not to be recommended as good practice. Too much of this quality sugar may have a tendency to jeopardize the now favorable position of beet sugar in this field.

Future work on this project will concern a study of the presence and significance of microorganisms of the mesophilic type. This group of microorganisms includes bacteria, yeasts and molds which grow best at atmospheric temperatures. The presence of these organisms in sugar has long been known but little interest has been given to this group. Recently, however, the American Public Health Association has undertaken studies to determine the most suitable methods for estimating their numbers, and significance in sugar.

Previous studies by the writer have indicated that relatively few of the mesophilic type of organisms are present in sugar as it leaves the centrifugals. The reason for this is that they are not especially resistant to heat as are the thermophilic types and are therefore killed in process. Contamination of sugar with this type usually begins in the wet box and

TABLE II

Bacteriological Examination of 1938 Sugars for Thermophilic Bacteria.

Carbohydrate Division Number	Aerobes Total Count per 10 g.	Aerobes Flat sour per 10 g.	Anaerobes Sulfide per 10 g.	Anaerobes Hard Swell % tubes with growth	Carbohydrate Division Number	Aerobes Total Count per 10 g.	Aerobes Flat sour per 10 g.	Anaerobes Sulfide per 10 g.	Anaerobes Hard Swell % tubes with growth
3801	125	15	0	0	3841	35	20	0	0
3802	5	0	0	0	3842	0	0	0	0
3803	40	15	0	0	3843	0	0	0	0
3804	35	10	0	0	3844	0	0	0	0
3805	15	0	0	0	3845	0	0	0	0
3806	15	0	0	0	3846	0	0	0	0
3807	5	0	0	0	3847	15	10	0	0
3808	0	0	0	0	3848	5	5	0	0
3809	0	0	0	0	3849	5	5	3	50
3810	25	0	0	17	3850	5	0	0	0
3811	10	0	0	0	3851	0	0	0	0
3812	0	0	0	0	3852	0	0	0	0
3813	0	0	0	0	3853	0	0	0	17
3814	0	0	0	0	3854	0	0	0	0
3815	0	0	0	0	3855	15	15	0	0
3816	160	75	0	0	3856	5	5	0	0
3817	25	5	0	0	3857	5	0	0	0
3818	40	25	0	17	3858	20	15	0	0
3819	0	0	0	0	3859	5	5	0	0
3820	10	10	0	0	3860	0	0	0	0
3821	95	45	0	0	3861	5	0	0	0
3822	10	10	0	0	3862	30	0	0	0
3823	0	0	0	0	3863	20	5	0	0
3824	75	10	0	0	3864	15	10	0	0

TABLE II (Cont'd)

Carbohydrate Division Number	Aerobes Total Count per 10 g.	Aerobes Flat sour per 10 g.	Anaerobes Sulfide per 10 g.	Anaerobes Hard Swell % tubes with growth	Carbohydrate Division Number	Aerobes Total Count per 10 g.	Aerobes Flat sour per 10 g.	Anaerobes Sulfide per 10 g.	Anaerobes Hard Swell % tubes with growth
3825	20	10	0	0	3865	15	5	0	0
3826	10	0	0	0	3866	20	0	0	0
3827	5	0	0	0	3867	200	55	0	0
3828	5	0	0	0	3868	20	5	0	0
3829	0	0	0	0	3869	0	0	0	0
3830	5	5	0	0	3870	0	0	0	0
3831	5	5	0	17	3871	0	0	0	0
3832	0	0	0	0	3872	50	25	0	0
3833	25	0	0	0	3873	5	5	0	0
3834	0	0	3	0	3874	0	0	0	0
3835*	225	75	0	0	3875	25	10	0	0
3836	20	10	0	0	3876	0	0	0	0
3837	0	0	0	0	3877	5	5	0	0
3838	45	30	0	0					
3839	0	0	0	0					
3840	30	15	0	0					

*Warehouse composite.

increases as the sugar progresses to the packaging machines. Additional contamination is possibly picked up during subsequent storage and handling. Any measures taken to prevent the sugar from coming into direct contact with exposed surfaces, unfiltered air, etc., will aid in keeping the numbers of these organisms at a minimum.

The progress of the American Public Health Association work, in which the writer is cooperating, will be discussed each year in this report. At present the study concerns the most suitable media, incubation times and temperatures for the determination of the types and their numbers in sugar.